EXHIBIT E

FOUNTAIN CREEK REACH 2
&
FIELDS PARK

PROJECT ASSESSMENT AND RESTORATION DESIGN DOCUMENT

Aquatic Assessment
&
Habitat Enhancement Plan
Fountain Creek - The Fields Park
City of Manitou Springs
El Paso County - Colorado

Prepared by

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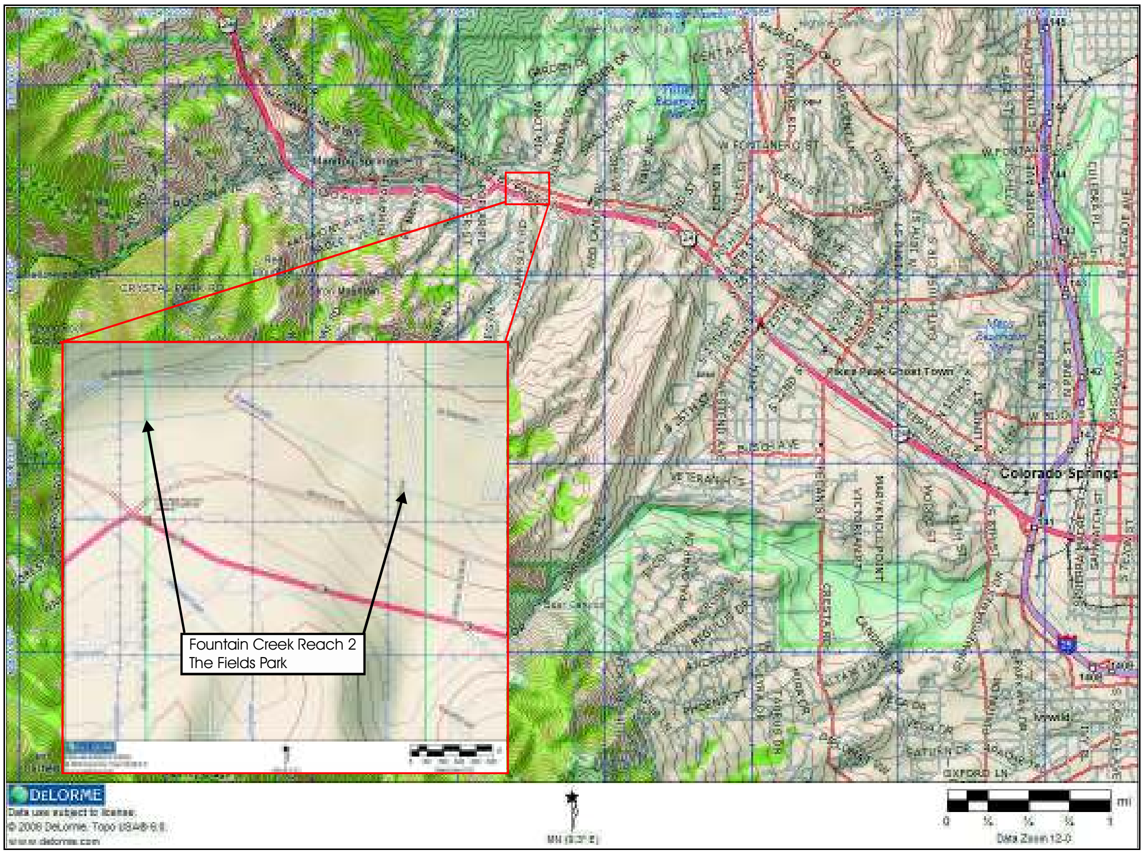
In February 2008, FIN-UP Habitat Consultants, Inc. was contracted by the City of Manitou Springs to conduct an aquatic habitat analysis and habitat enhancement strategy for a segment of Fountain Creek within The Fields Park, near the eastern limits of the city. The stream within the park is approximately 1,200 feet in length, consisting of a moderately entrenched natural channel flowing through a cottonwood and alder dominated floodplain. An aquatic assessment was conducted within the project area during the 2nd week of May, 2008, and the results of this study are summarized in this document.



Map 1: Location of project reach on Fountain Creek - The Fields Park, Manitou Springs, CO.

Watershed and Hydrology

The headwaters of Fountain Creek consist of several perennial streams with headwaters in the city of Woodland Park and along the north slope of Pikes Peak. The watershed extends downstream to the confluence with Monument Creek near downtown Colorado Springs. The aspect of the watershed is mostly southeasterly. The headwaters of Fountain Creek watershed have a contributing drainage area of approximately 119 square miles at its confluence with Fountain Creek and Monument Creek near downtown Colorado Springs.

Most of the headwaters are part of the Pike National Forest and are dominated by pine and fir forest on very steep slopes consisting of decomposing Pikes Peak granite. Urban development is present in the headwaters, and is likely influencing the watershed. Urban areas include a portion of Woodland Park, and the communities of Crystola, Green Mountain Falls and Cascade. In the middle portion of the watershed, the Pike National Forest continues with pine and fir forest. The stream emerges from a steep canyon immediately upstream of the city of Manitou Springs, where the surrounding geology changes from decomposing granites to the tilted sedimentary layers of the Dakota Hogback. The lower portion of the headwater Fountain Creek watershed contains the city of Manitou Springs and has been developed with interspersed commercial, industrial, and residential areas.

The upstream portion of the creek is a mountain stream with boulders, cobbles, and gravel in a narrow valley. Through the city of Woodland Park, the creek transitions to a wide sand-bed channel. Downstream of the city of Woodland Park, the channel becomes a mountain stream with boulders and natural drops and pools along U.S. Highway 24. The main channel throughout much of this segment has been dramatically altered by the construction of US Highway 24, and exhibits a step-pool morphology characteristic of a stream flowing through a narrow and confined valley/canyon. Downstream of the canyon and through the city of Manitou Springs, the stream has been channelized in several segments, and is diverted underground in many places. Downstream of the city of Manitou Springs, the channel continues to be somewhat entrenched, with occasional meanders down to the confluence with Monument Creek.

Eight major tributary streams contribute to Fountain Creek between its headwaters and the project area in The Fields Park within the Town of Manitou Springs. These streams include Catamount Creek, Crystal Creek, Severy Creek, French Creek, Ruxton Creek, Williams Canyon Creek, and Sutherland Creek. Five of these major headwater tributaries have significant reservoirs or other water diversion structures, affecting the natural hydrology of the basin.

The US Geological Service (USGS) Hydrologic Unit of the watershed is 1102000301. The nearest automated stream gauge to the project area is located behind the Safeway west of 31st St in Colorado Springs, and is maintained by the USGS and Colorado Springs Utilities (CSU). The location of this gauge is at Latitude 38°51'17"", Longitude 104°52'39", in the SE¼SW¼ of Section 3, Township14 S., Range 67 W., on left bank 200 ft upstream from the water diversion for Colorado Springs Utilities, and approximately 1.0 mi downstream from Sutherland Creek. The watershed area upstream of this gauge is approximately 103 square miles. A 48 year record of flow data is available at this site. For the period of record, peak yearly flows have ranged from a minimum of 43cubic feet per second (cfs) to 2630cfs. The median peak flow during the period of record was 340 cfs.

Extensive hydrologic modeling has been conducted in the watershed using the HEC-HMS model developed by the US Army Corps of Engineers (*Fountain Creek Watershed Preliminary Hydrology Report, URS, 2005*). The model was run at several locations along Fountain Creek upstream of the gauge, applying a 24-hour storm event with 2, 5, 10, 25, 50, and 100-year recurrence intervals. The HEC-HMS models of current conditions in the watershed indicate that the bank full stage discharge at the USGS gauge is approximately 330 cfs. Upstream of the gauge, within the Fields Park project area, bank full stage discharge is estimated to be approximately the same as the gauge. A table of the HEC-HMS predictions for above bank-full stage recurrence intervals is shown in the Table 1. Based on the HEC-HMS modeling and cross sectional channel data collected during this assessment, it is estimated that the stream will exceed the carrying capacity of the existing channel in the park at approximately 3,750 cfs, or somewhat less than a twenty-five year flood event. At this flow, average velocities in the channel may be expected to reach 16 feet per second, exerting in excess of 7 lbs/ft^2 of sheer stress within the channel and 2 lbs/ft^2 on the adjacent stream banks.

		Estimated Peak Discharge (cfs)					
Location	Area (Mi^2)	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
At 31st St (USGS near Colorado Springs Gauge)	103	330	690	2000	5300	8800	13000
At US Hwy 24 near Manitou Bypass	97	330	630	1800	4900	8200	12000

Table 1: Peak Discharge Return Interval Estimates Using HEC-HMS models

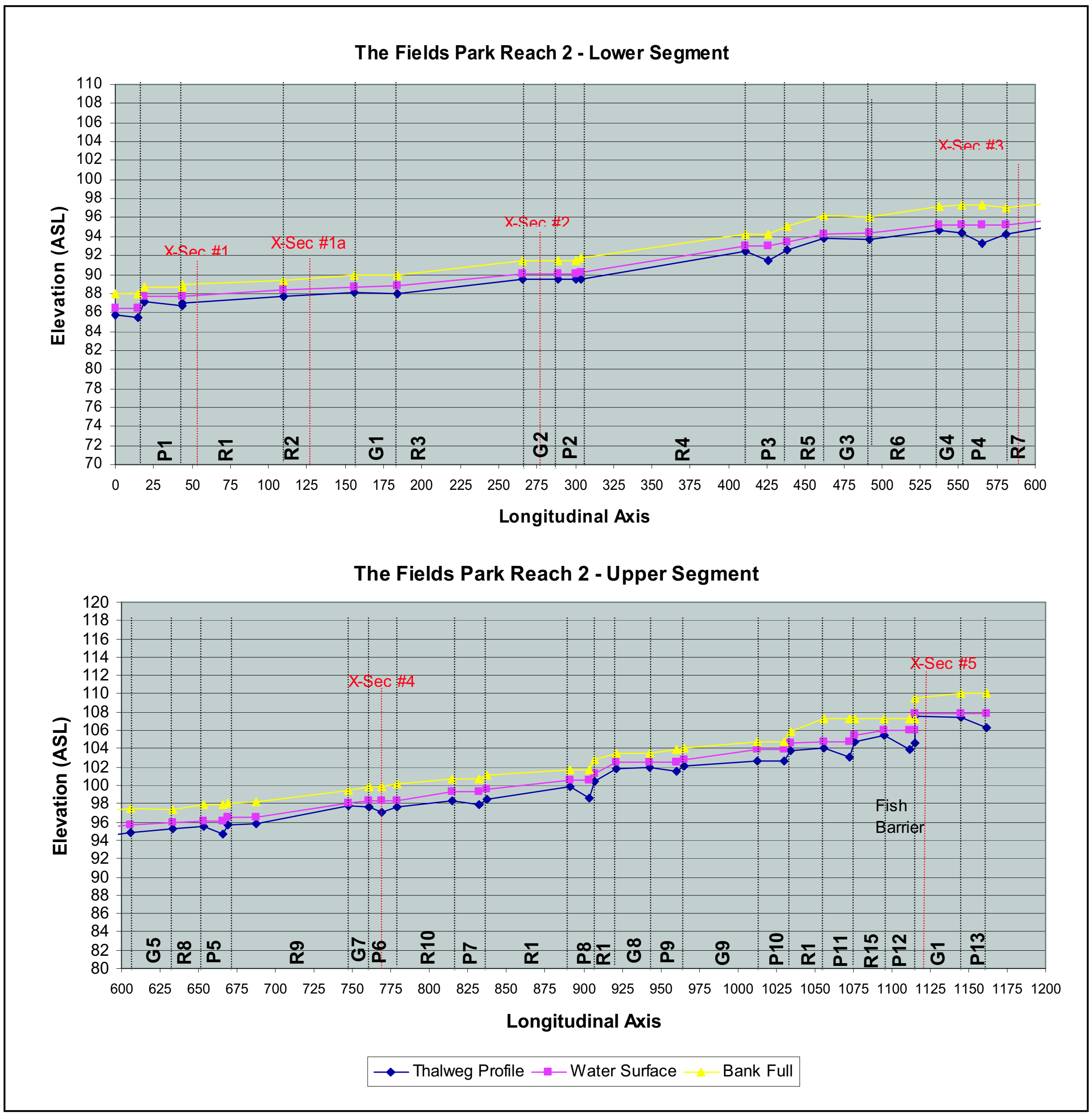
Existing Fish Populations

Fountain Creek contains resident populations of both native and non-native fishes. Three important native species are present in the watershed, including the greenback cutthroat trout (*Oncorhynchus clarki stomias* - federal and state threatened), the Arkansas darter (*Etheostoma cragini*- state threatened) and the flathead chub (*Platygobio gracilis* - a state species of special concern); however none of these species are present in the project reach. Brown trout (*Salmo Trutta*) and brook trout (*Salvelinus fontinalis*) are the most common non-native salmonids in Fountain Creek, and have been observed in the project reach. Additionally, rainbow trout (*Oncorhynchus mykiss*) are occasionally stocked by private individuals, and may or may not remain resident in the watershed. An electro-fishing monitoring site has been established several hundred feet upstream of the project area and is routinely monitored by the Colorado Division of Wildlife and the USGS. During the most recent sampling in 2005, 42 adult brown trout were captured within the station.

Photo 1: Typical Brown Trout in Reach 2 of Fountain Creek.

Stream Channel and Habitat Assessment Methods
For the purposes of this assessment, Fountain Creek through Manitou Springs was delineated into distinct reaches, or segments, based on valley type, channel morphology, perennial vs. intermittent flows, and administrative or physical boundaries. Reaches were numbered consecutively, beginning at the furthermost downstream ranch boundary, and continuing upstream to the headwaters. A total of 13 reaches were identified within the city limits. The Fields Park study reach is designated as Manitou Springs Fountain Creek Reach 2.

Stream Channel Morphology:
Stream reaches are classified using the Rosgen Stream Classification System (D.L. Rosgen, CATENA, 1994). The Rosgen classification system groups streams by similar channel geomorphology, gradient, sinuosity and function. The classification system is stratified into three progressive levels, based on channel form, dominant substrate, and



gradient. A detailed description of the Rosgen Channel Classification System was included in previous assessments for Soda Springs Park (Reach 11) and Shryver Park (Reach 2) and may be used for reference.

For the purposes of the stream channel morphology study, six cross-sections were established and numbered consecutively beginning at the downstream boundary of the reach and continuing upstream. All directional references to stream banks and cross-sectional head pins are for the channel geometry study are from a hydrologist's perspective, with left and right banks determined looking downstream along the channel. Chart 1: Longitudinal Profile of Reach 2 on Fountain Creek.

A longitudinal profile (Chart 1) of the stream channel and the cross-sections were established in July 2008. Stream flow was measured at cross-section #2, using a Marsh-McBirney FlowMate 2000 flow meter, and was calculated to be 11.5 cfs. The longitudinal profile is typical of Fountain Creek through the City of Manitou Springs, characterized by relatively low gradient, a moderate to high degrees of entrenchment, and infrequent pool habitat. The average slope of the channel, water surface and bank full elevation throughout the profile was 2%. Riffle slopes ranged from 0.5% to 3%, with a reach average of 2%. Stream channel sinuosity was low (<1.5) in the reach, as would be expected for a B type channel.

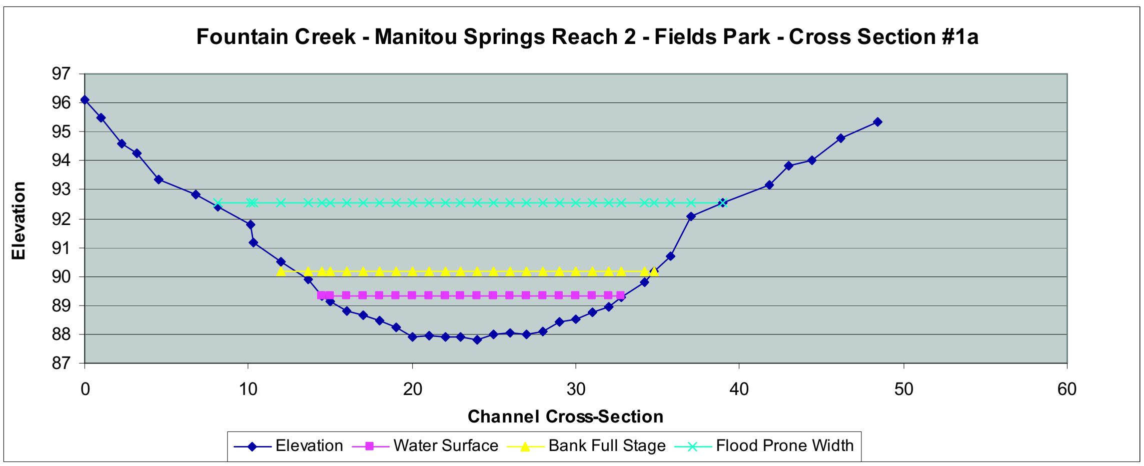


Chart 2: Cross Section #1a on Reach 2 of Fountain Creek - Typical Riffle Habitat.

Cross-sections #1, #1a, and #3 show representative profiles of typical riffle habitat within the reach. The riffle cross-sections are dominated by larger substrate particle sizes, resulting in greater velocity complexity and surface turbulence. Chart 2 above shows a typical riffle cross-section in the reach. Cross-sections #2 and #5 were surveyed within glide habitats in the reach, with a typical profile shown in Chart 3. These cross-sections exhibit the typical uniform channel elevation and laminar flow characteristics of the glide meso-habitat form. Cross-Section #4 was surveyed in a trench pool at P6, which was the most typical form observed in the reach, and exhibits a maximum bank-full depth of just under 2.7 feet. This profile can be seen in Chart 4. All of the cross-section surveys may also be found in the appendix.

Each of the cross-sections exhibits the moderate to high entrenchment characteristics of the stream channel within the reach. Entrenchment ratios of 1.3 to 3.3 were observed at the cross-sections. Most of the cross-sections exhibited entrenchment of < 1.6. Width/depth ratios ranged from 8 to 14, with an average of approximately 11.4. W/D ratios in the upstream segment of the reach were less than would be expected to occur in a B channel, and may indicate that the channel has down-cut and begun to exhibit more of a G characteristic.

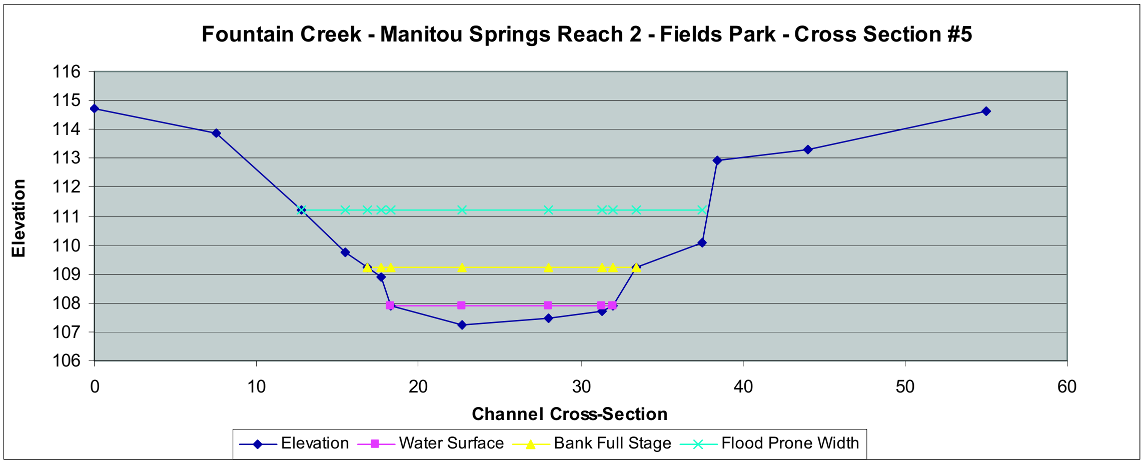


Chart 3: Cross-Section #5 on Fountain Creek - Typical Glide Habitat.

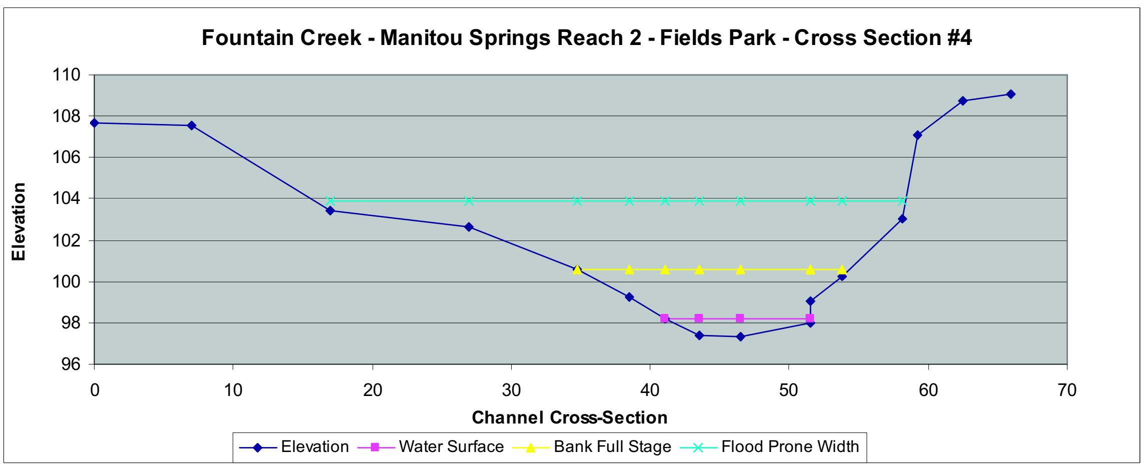


Chart 4: Cross-Section #3 on Fountain Creek - Typical Pool Habitat.

The general reach substrate was calculated using a Z-Walk pebble Count (Bevenger, 1997) and the results are shown in Table 1. A tri-modal distribution of smaller particles (fines), large gravel/small cobble, and small boulder is apparent in the pebble count data (Chart 5), and suggests that sediment inputs to the stream may exceed the capacity of the stream to move the material. The D50 (mean) particle size is estimated to be approximately 8mm, and the D84 particle size is estimated to be 225mm. Particle size ran from very fine sand to large boulders in excess of 1 meter along the medial axis. Large wood (>4" diameter and > 3' long) is extremely scarce in the reach, with only seven pieces observed, and mostly associated with old drop structures. Large wood is an important habitat forming component for rivers in the Rocky Mountains, and provides cover and complexity to the aquatic ecosystem.

Wolman Pebble Count		Class	Total	% of	Cumulative
Metric - mm	Inches	Name	Number	Total	%
<.066		Silt		0.00%	0.00%
.066 -.125		Very Fine	10	3.25%	3.25%
.125-.25		Fine	41	13.31%	16.56%
.25-.50		Medium	22	7.14%	23.70%
.50-1.0		Coarse	12	3.90%	27.60%
1.0-2.0		Very Coarse	15	4.87%	32.47%
2.0-4.0		Very Fine	22	7.14%	39.61%
4.0-8.0		Fine	37	12.01%	51.62%
8.0-16	.08-.6	Medium	29	9.42%	61.04%
16-32	.6-1.3	Coarse	23	7.47%	68.51%
32-64	1.3-2.5	Very Coarse	14	4.55%	73.05%
64-128	2.5-5.0	Small	19	6.17%	79.22%
128-256	10-May	Large	22	7.14%	86.36%
256-512	20-Oct	Small	25	8.12%	94.48%
512-1024	20-40	Medium	8	2.60%	97.08%
1024-2048	40-80	Large	9	2.92%	100.00%
2048-4096	80-160	Very Large		0.00%	100.00%

Table 1 - Results of the Wolman Pebble Count, showing distributions of substrate size classes in Reach 2 on Fountain Creek.

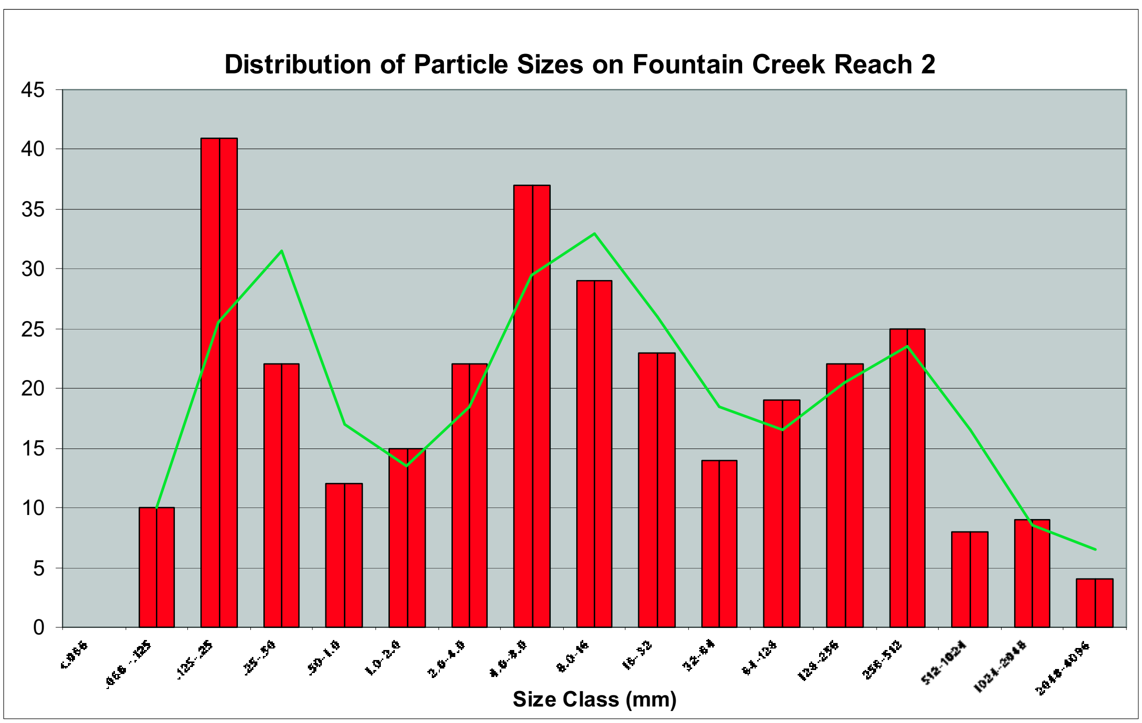


Chart 5 - Distribution of particle size classes distribution of sand and larger cobbles and boulder in Reach 2 on Fountain Creek.

Based on the reach longitudinal profile survey, the channel cross-section analysis, and the stream substrate data, the channel was determined to be a B4 type. The channel appears to be relatively stable at this time, but is affected by high flow shear forces eroding unstable and unvegetated stream banks in the upper portion of the reach. Sediment from these eroding banks, and from sources upstream of the reach appear to be accumulating in the pools and smaller velocity shelters in the channel and are likely having a negative effect on the quantity and quality of useable habitat for resident trout.

Photo 2: Typical Cobble Riffle (Riffle #4) on Reach 2 of Fountain Creek

Aquatic and Riparian Habitat Assessment Protocols:
Assessments characterize existing habitat conditions and evaluate current management and restoration potential. The stream reach is analyzed using a basin-wide stream habitat survey protocol developed by the US Forest Service and Colorado Division of Wildlife for smaller streams in the Rocky Mountain Region (Winters and Gallagher, 1997). This protocol is a modified basin-scale aquatic habitat inventory based on the Hankin & Reeves survey method. All meso-habitat types within a delineated reach are measured for multiple attributes, including physical dimension, morphic form, bank condition and composition, substrate class, and cover for salmonids. The advantage of the Winters protocol is that it is a repeatable method, and therefore can be used to quantify changes in habitat resulting from management, habitat enhancement, or natural events. A copy of the Winters Protocol is provided as a separate document under this contract. For the purposes of the stream and riparian habitat study, all directional references are from a fisheries biologist's perspective, with left and right banks determined looking upstream along the channel.

Aquatic Habitat Survey Results:
The project reach for this study is located in on the eastern part of Manitou Springs and is delineated as Reach 2 (Map 1). Reach 2 on Fountain Creek encompasses all of The Fields Park, beginning at the bridge where Becker's Lane crosses Fountain Creek. The reach continues upstream 1,179 feet to a chain link fence on either side of the creek that delineates the Colorado Department of Transportation easement west of The Fields Park.

A rapid assessment of aquatic habitat was undertaken within the reach, and a detailed stream habitat inventory was conducted in May, 2008 within the project area. Discharge was measured during the survey at a point approximately in the middle of the project area using a Marsh-McBirney Flow-Mate 2000 flow meter, and was calculated to be 11.5 cubic feet per second, which is within the estimated base flow range for the stream.


Photo 3: Potential fish barrier on Reach 2 - The Fields Park.

Reach 2:
Reach 2 has not been dramatically altered through channelization and encroachment of urban development. The reach is characterized by a moderately incised channel through relatively stable depositional material composed mostly of larger gravel and small cobble. The stream exhibits a very narrow valley bottom with minimal riparian green-line, low sinuosity and moderate (2%) gradient. Habitat for trout appears to be somewhat limited due to the very high sediment supply available from both upslope and channel derived sources. A significant large log drop structure exists in the reach near the upstream boundary (Photo #3). This structure appears to be a significant barrier to fish passage through the reach, and appears to be in imminent risk of failure. Initial reconnaissance indicates that Reach 2 exhibits generally poor quality aquatic habitat. Sedimentation from local erosion sources, as well as Sutherland Creek and other sources upstream are negatively impacting aquatic habitat within the reach.

There were 38 individual meso-habitats measured in the reach (14 pools, 14 riffles and 10 glides), along a length of 1,179 feet of stream, and comprising a total wetted area of 15,933ft^2. The total area of the reach consisted of 50% riffles and 29% pools, with the remaining 21% consisting of glide habitat (Chart 6). The average wetted width of the stream was 13.7 feet throughout the reach. Stream bank stability throughout much of the reach was generally good, with alder, willow and cottonwood comprising most of the riparian vegetation. Several areas of bank degradation and instability are found within the reach. The causes of stream bank instability in these areas include bank failure from shear at high flows and heavy recreational use, particularly on the north, right stream bank adjacent to the park. There were 427 feet of actively eroding stream banks contributing sediment directly into the stream. This accounted for slightly more than 18% of the total length of banks in the study reach.

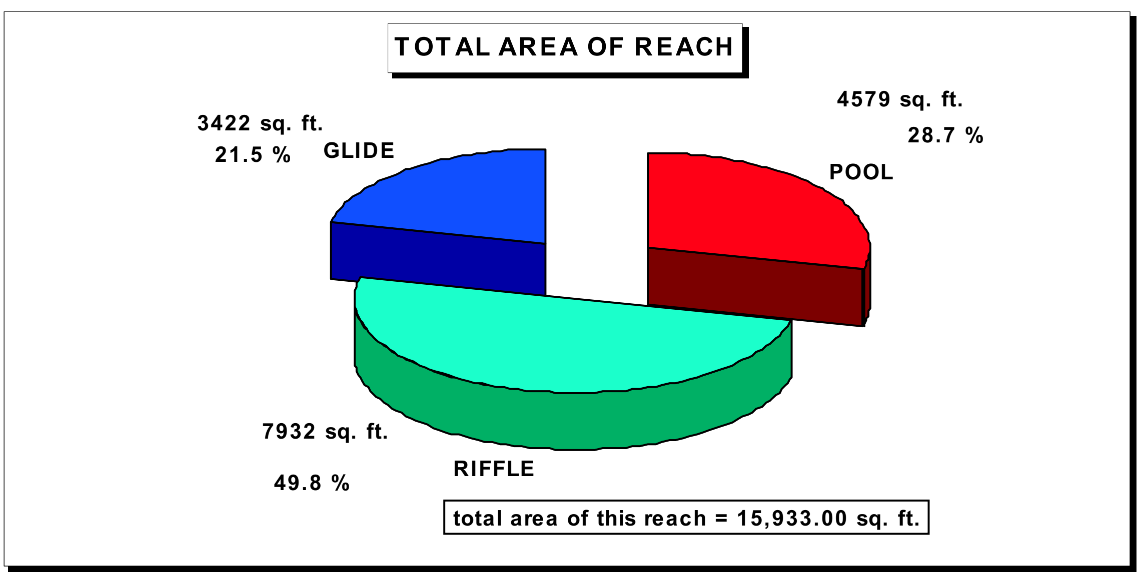


Chart 6 - Distribution of Pool, Riffle and Glide habitats in Reach 2 of Fountain Creek.

Higher gradient boulder dominated riffles exhibiting pocket water characteristics were the most common habitat type in terms wetted area, accounting for 27% of the total reach area (Chart 7). Lower gradient, cobble and gravel dominated riffles were the next most common habitat, accounting for 9% and 8% of the wetted area of the reach respectively. Low gradient riffles can provide good spawning habitat, but are somewhat limited in terms of cover from high flows and predators. Generally, a good mix of higher gradient pocket water riffles providing cover and velocity shelter, combined with lower gradient cobble and gravel riffles for spawning habitat, should provide excellent habitat conditions for resident trout. In the case of Reach 2, however, excess sediment from sources upstream has reduced the quality and utility of these micro habitats. Overall, very little cover for trout was observed in these riffles, amounting to less than 0.5% (37 ft^2) of the total wetted area of these habitat types. The average width of all the riffles observed in the reach was 12.7 feet.

Photo 3: Lower half of The Fields Park project reach, looking upstream.

Pool habitat is somewhat limited in the reach, with trench pools being the most abundant, comprising 15% of the total wetted area of the reach (Chart 2). The trench pools were mostly associated with constrictions in the stream channel created by cottonwood and other tree root systems, and boulders along the stream bank. Dam pools and plunge pools were also observed in the reach, accounting for somewhat less wetted area than the trench pools. One of the plunge pools is principally associated with log-drop structure near the upstream boundary of the reach. This plunge pool consists of a 3 ft drop that may be a barrier to migration of trout through the reach. This structure is beginning to fail, which will result in a new head-cut migrating upstream into Reach 3.

Dam pools and plunge pools comprised 14% of the total wetted area of the reach. All of the pools exhibited some degree of in-filling of sediment, mostly consisting of smaller particles of decomposed granite. The average pool depth in Reach 2 was 0.94 feet. Residual pool depth (RPD) in Reach 2 was found to range from 0.1 to 1.7 feet, with an average of 0.9 foot throughout the reach. It is interesting to note that pool depth and RPD were significantly less than in Reach 4 (Shryver Park), and is likely due to sedimentation impacts from Sutherland Creek. RPD in Reach 2 is considered to be very poor, and may limit adequate over-wintering habitat for salmonids and other native species in this segment of Fountain Creek.

Cover for trout accounted for less than 4% of the total wetted area of the pools, which is very poor for a stream of this size. The average wetted width of all pool types found within the reach was 13.9 feet.

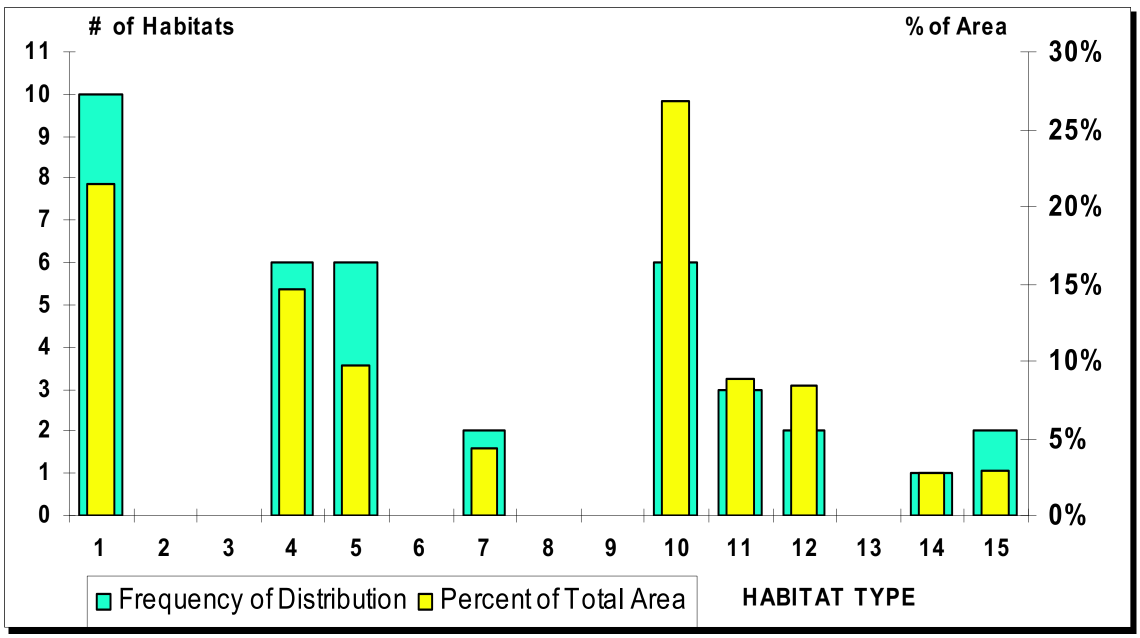


Chart 7 - Distribution of Meso-Habitat Types as a percentage of # of habitats and as a percentage of wetted perimeter of Reach 2 on Fountain Creek.

A considerable number of glides were observed, comprising slightly more than 21% of the reach. Glide habitat appeared to be the result of excessive sediment inputs upstream. Most of the glide habitats observed appeared to be former pools that had been completely in-filled with gravel and smaller diameter materials. Cover for trout was extremely limited in these habitats, which are characterized by laminar flow profiles and tend to provide little velocity shelter or protection from predators. Aggradation of sediment in the glides is resulting in a gradual over-widening of the bank full channel in these meso habitat forms. The average width of the glides observed in Reach 2 was 14.5 feet.

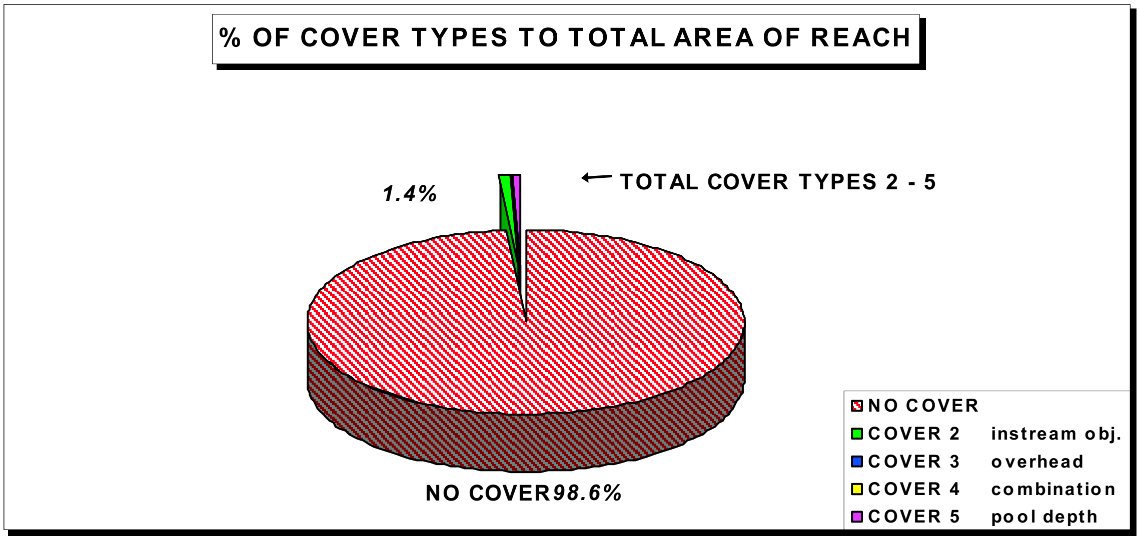


Chart 8 - Percentage of cover for trout to the total wetted perimeter Reach 2 on Fountain Creek.

All forms of cover for adult trout accounted for only 1.4% of Reach 2 (Chart 8). Available cover was significantly less than that observed in Reach 4 (Shryver Park), appears to be a significant limiting factor to the health of the fishery. Creating additional cover will be an important component in the Habitat Enhancement Plan. Instream object cover (Cover Type 2 - >1' deep) was the dominant type observed in the reach, but was limited mostly to the pool habitats. Pool cover (Cover Type 5 - >1.5'deep) was very limited in the reach, and comprised only 1.6% of the wetted area of the pools and 0.5% of the total reach area. Pool cover is an important indicator for determining the available over-wintering capacity of the stream reach, and appeared to be severely limited in this reach. Combination and overhead cover were the least abundant cover types, due to the lack of velocity shelter along the stream bank and limited large wood in the channel. Instream and overhead cover could be enhanced in the riffle habitats by adding structure and velocity shelters along the stream banks with strategically placed boulders and large wood. Pool cover may be increased by improving scour in existing pools as well as creating new pool habitats. Combination cover may be improved throughout the reach through stabilizing and revegetating the eroding stream banks using large wood toe-slope stabilization techniques.

Stream bank stability was generally fair to poor in the reach, depending on vegetation composition degree of recreation use along any particular stream bank. Generally well vegetated stream banks were found on the side of the stream opposite of The Fields Park. Several areas of actively eroding stream banks were observed, particularly along the side of the stream adjacent to the park, and in the upstream half of the reach where the channel is more deeply entrenched. Forty-eight percent of the left bank and 63% of the right bank were found to be stable. The remaining 52% of the left bank and 37% of the right bank were found to be generally unstable and at risk of failure due to high flow shear forces on the banks (Chart 9). Bank rock content in the reach is shown in Chart 10, and consisted principally of gravel and smaller fragments (Type 8). Smaller fragments of less than 1/8" were the most dominant type, indicating that the stream banks are more susceptible to erosion due to high flows than other reaches already assessed in Manitou Springs.

Photo 5: Eroding Stream Bank near the center of The Fields Park Reach 2.

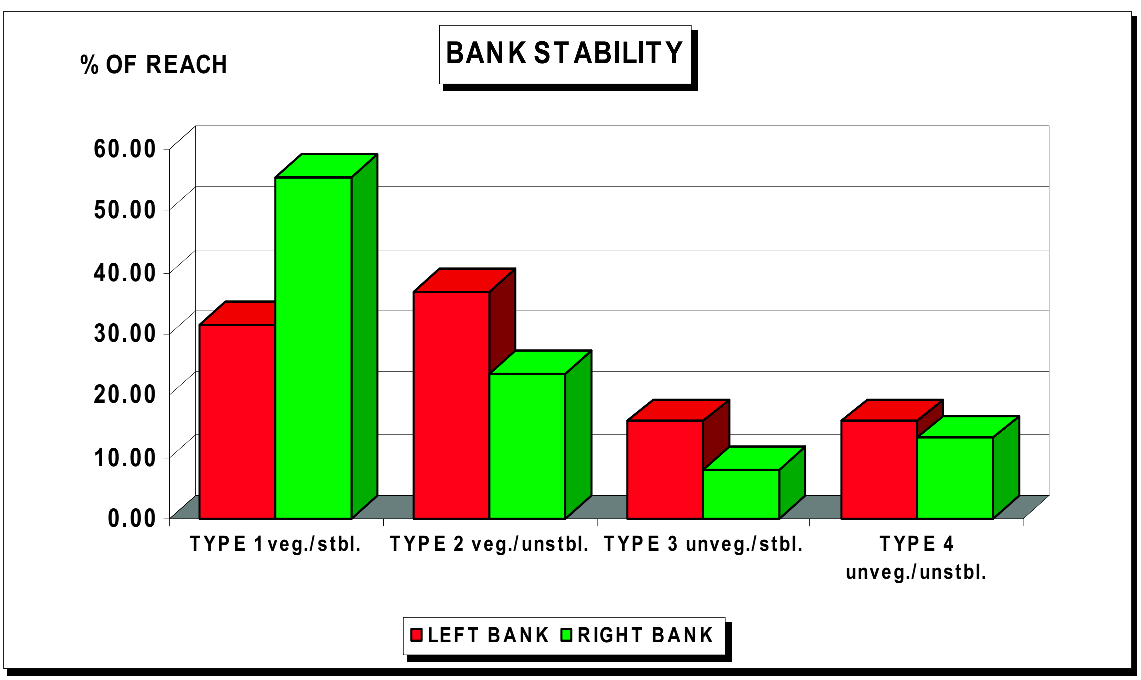


Chart 9 - Percentage of stable banks to unstable banks in Reach 2 on Fountain Creek.

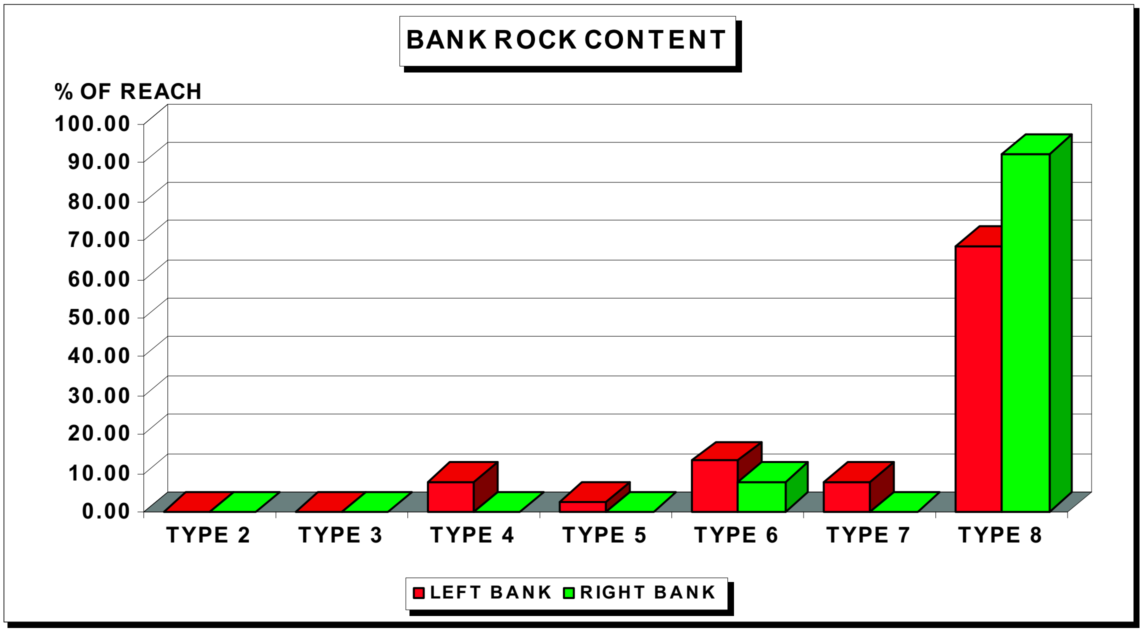


Chart 10 - Percentage of bank rock content sizes in Reach 2 on Fountain Creek.

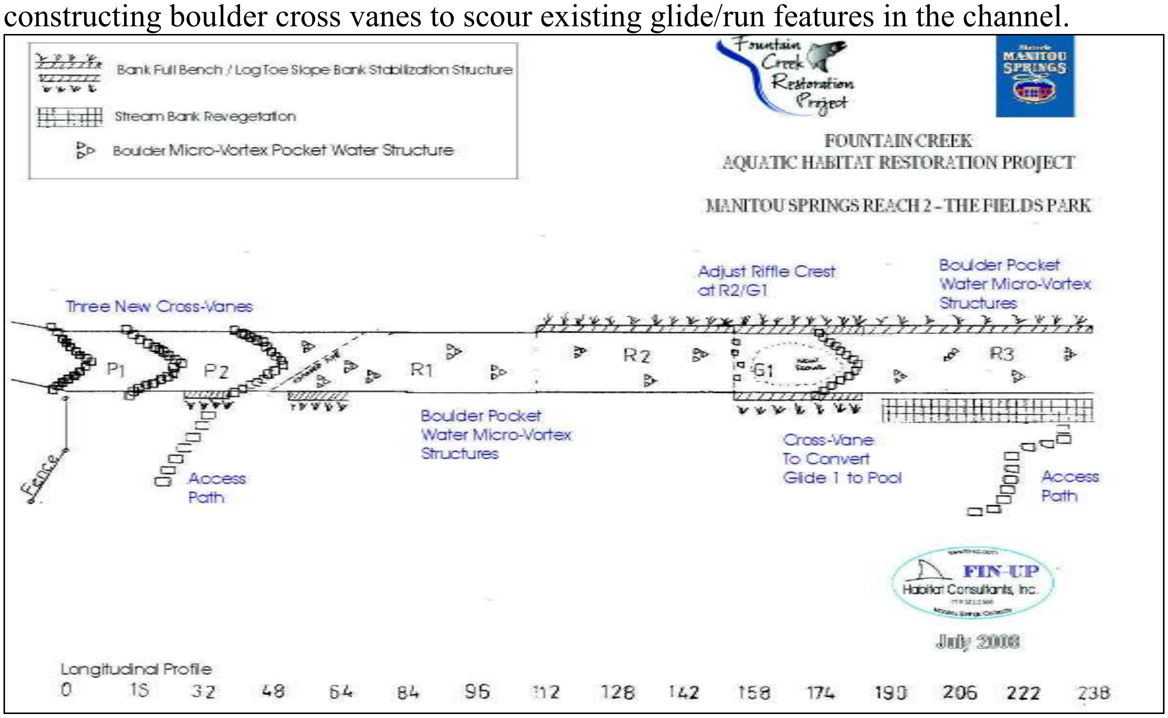
Aquatic habitat conditions throughout Reach 2 were generally very poor. Limiting factors to the fishery appear to be excessive sedimentation due to sediment from s upstream areas and contributing tributaries, resulting in poor quality pool habitat, and limited in-channel object cover in both the low gradient and pocket water riffles. Several problem areas were identified during the course of the inventory that should be addressed in order to alleviate potential worsening problems and loss of habitat, as well as to help the river achieve its full potential as a cold water fishery.

Photo 6: Typical poorly formed pool habitat - The Fields Park Reach 2.

Aquatic Habitat Enhancement Plan for Fountain Creek - Reach 2.
The reach of Fountain Creek flowing through The Fields Park in Manitou Springs may benefit from efforts to restore of the channel, stream banks, and associated aquatic and riparian habitats. Several factors, however, may constrain any effort to return the stream to its natural hydrologic function. These include the inability to significantly change the dimension, pattern or profile of the channel through the reach, due to urban development along the stream banks, and the existence of utilities running under the stream in several areas. There are, however, some improvements that may enhance the stream corridor, both in terms of hydrologic and habitat function, as well as the esthetic values of the reach.

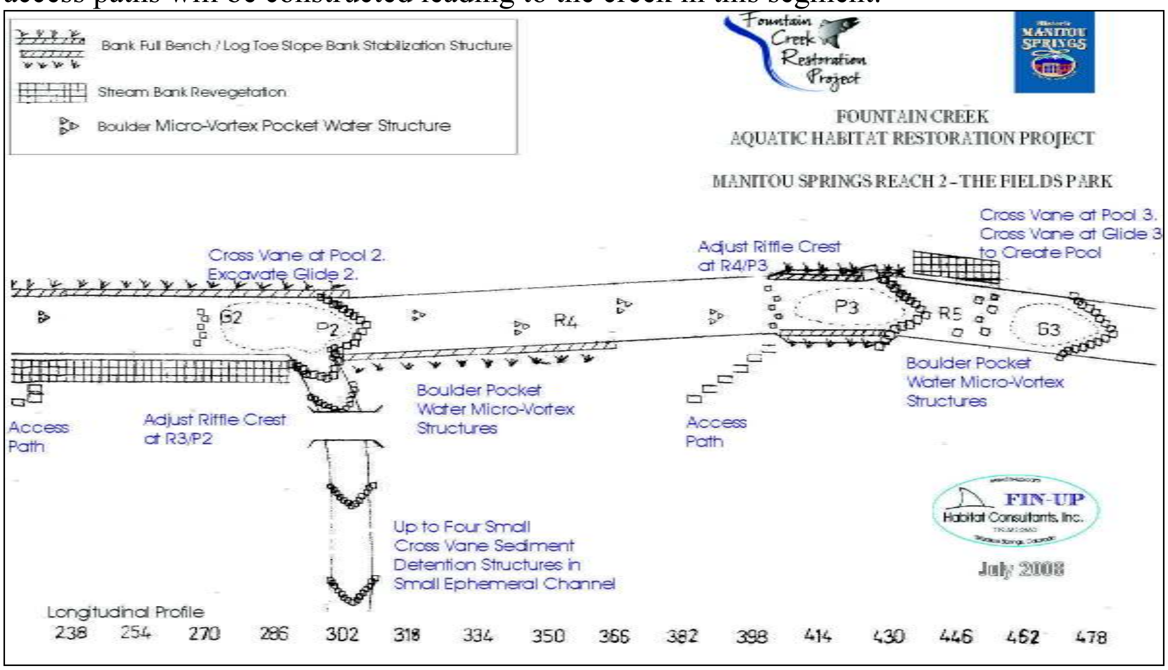
The priority will include bank stabilization and re-vegetation, as well as in-channel stream habitat enhancement within the remaining segments of Reach 2 in The Fields Park. The following section will address these priorities, and give specific recommendations and treatments to improve aquatic and riparian habitat conditions throughout the reach. Site plans showing the locations of the proposed enhancements can be found in the Appendix.

Aquatic Habitat Enhancements and Stream Bank Stabilization
Natural river restoration techniques will be utilized to enhance and restore 1,150 feet of Fountain Creek, creating new holding areas and cover for trout within the project reach. Pool scour will be enhanced by adjusting boulders to optimize the river's capacity to move sediment. Enhancing pool scour should increase average pool depth and residual pool depth in the channel, providing additional cover and over-wintering capacity for trout, and are expected to be self-maintaining. Pool habitat will be increased by constructing boulder cross vanes to scour existing glide/run features in the channel.



Plan view of Habitat enhancements and bank stabilization from Pool 1 through Riffle 3 of Reach 2 of Fountain Creek within The Fields Park.

Two boulder cross-vanes will be installed at the downstream boundary of the reach, enhancing the existing plunge pools in this location. These cross vanes will also provide enhanced vertical stability in the stream channel. Pocket water cover will be increased within Riffle 1, 2 & 3, using small rock cluster vortex structures. Glide 1 will be converted to a pool by installing a boulder cross-vane near the top of this habitat, improving scour through the feature. 178 feet of stream bank will be stabilized using large wood and/or boulders embedded in the toe of the bank slope to create riparian benches at the bank-full elevation of the stream channel. Willows and sedge mats will be planted along these benches, creating a small riparian floodplain. Additional slope stabilization and re-vegetation will take place above the toe-slope structures, using landscaping timbers and other features to create benches that will capture sediment and run-off from the adjacent park areas. 48 ft of stream bank will be re-vegetated without toe-slope stabilization. Stabilized slopes will be covered with biodegradable geo-textile fabric and planted with native willow, sedge and upland grasses. A minimum of two access paths will be constructed leading to the creek in this segment.

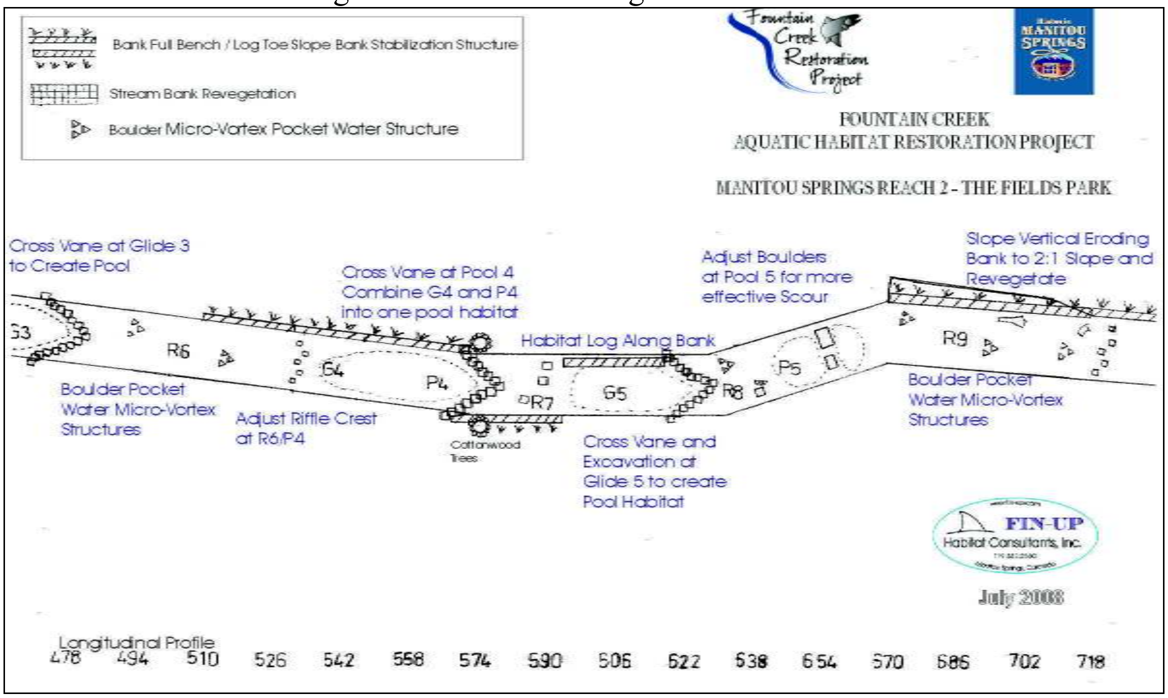


Plan view of Habitat enhancements and bank stabilization from Glide 2 through Glide3 of Reach 2 of Fountain Creek within The Fields Park.

Glide 2 has formed due to the in-filling of sediment in Pool 2, and will be excavated, with spoils removed completely from the site. A cross-vane will be constructed at Pool 2 to improve scour through the feature. Additionally, up to four small sediment detention structures will be constructed on the small tributary channel adjacent to Pool 2 to reduce sediment inputs from this channel. Small boulder will be used to slightly raise the riffle crest of Pool 2, further enhancing the RPD.

The elevations of existing boulders in the channel in Riffle 4 & 5 will be adjusted to produce more effective pocket water and velocity shelter. Excess accumulated sediment will be excavated from Pool 3, and a small cross vane will be installed. Glide 3 will be converted to a pool habitat through construction of a boulder cross vane and excavation.

130 feet of stream bank will be stabilized using large wood and/or boulders embedded in the toe of the bank slope to create riparian benches at the bank-full elevation of the stream channel. Willows and sedge mats will be planted along these benches, creating a small riparian floodplain. 95 ft of stream bank will be re-vegetated without toe-slope stabilization. Stabilized slopes will be covered with biodegradable geo-textile fabric and planted with native willow, sedge and upland grasses. A minimum of two access paths will be constructed leading to the creek in this segment.

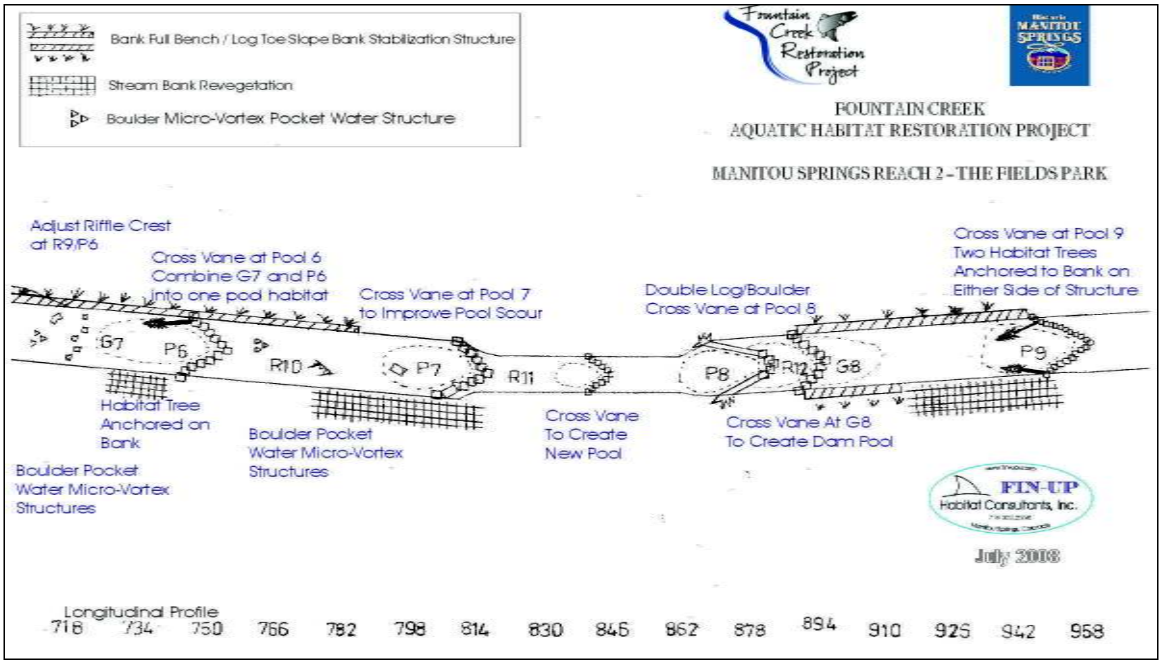


Plan view of Habitat enhancements and bank stabilization from Glide 3 through Riffle 9 of Reach 2 of Fountain Creek within The Fields Park.

Glide 4 suffers from similar sedimentation effects as Glide 2, and has formed due to the in-filling of sediment in Pool 4. This feature will be excavated, with spoils removed completely from the site. A cross-vane will be constructed at the transition of Pool 4 and Riffle 7 to improve scour through the pool. Glide 5 will be converted to a pool by installing a boulder cross-vane near the top of this habitat and by raising existing boulders at the riffle crest between Riffle 7 and Glide 5. Additionally, a habitat cover tree may be anchored to the left (south) stream bank along the new pool created at Glide 5.

New small boulder clusters will be installed, and existing boulders in the channel in Riffle 6, 7, 8, & 9 will be adjusted to produce more effective pocket water and velocity shelter. A minor adjustment to the existing boulders forming Pool 5 may be made to improve this habitat.

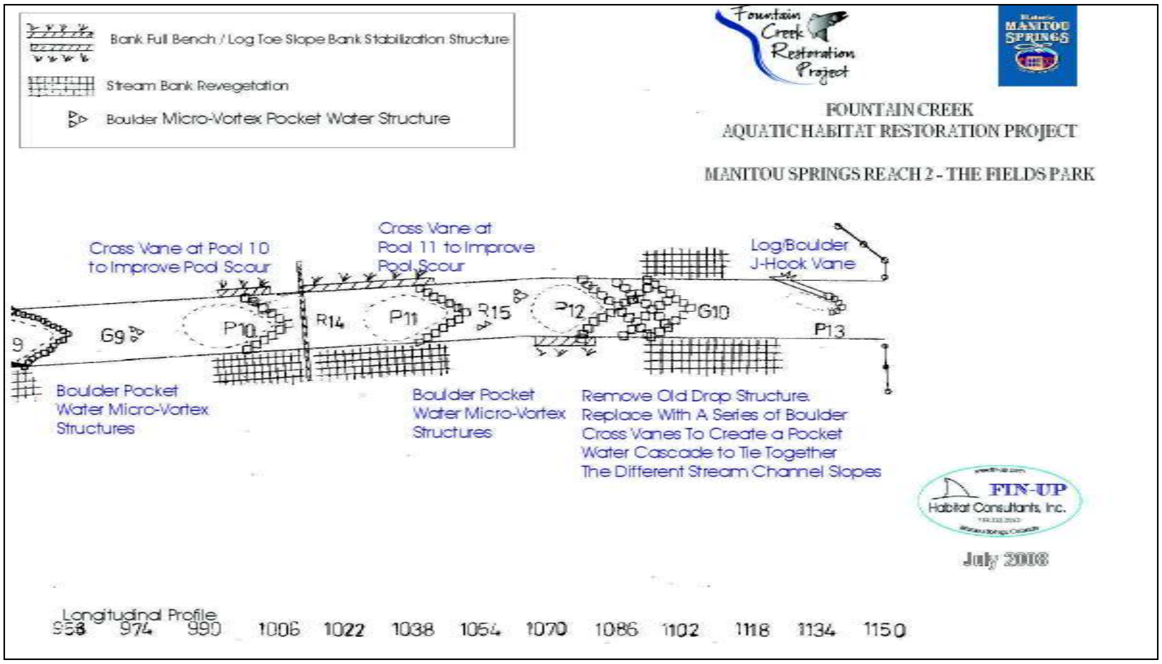
120 feet of stream bank will be stabilized using large wood and/or boulders embedded in the toe of the bank slope to create riparian benches at the bank-full elevation of the stream channel. Willows and sedge mats will be planted along these benches, creating a small riparian floodplain. Additional access paths will be constructed leading to the creek in this segment.



Plan view of Habitat enhancements and bank stabilization from Riffle 9 through Pool 9 of Reach 2 of Fountain Creek within The Fields Park.

Glide 7 has formed due to the in-filling of sediment in Pool 6. This feature will be excavated, with spoils removed completely from the site. A cross-vane will be constructed at the transition of Pool 6 and Riffle 10 to improve scour through the pool. The riffle crest at the transition of Riffle 9 and Glide 7 will be adjusted to improve residual pool depth and cover. Additionally, a habitat cover tree may be anchored to the left (south) stream bank. Scour in Pool 7 will be enhanced by installing a boulder cross vane immediately upstream. A new pool will be created within the existing Riffle 11 by installing a small boulder cross vane. A double log/boulder cross vane will be installed at Pool 8 to improve scour and depth. The logs will be anchored using Manta-Ray MR-1 or equivalent dead-man anchors. A boulder cross vane will be installed at the transition of Riffle 12 and Glide 8 to create a dam pool habitat in the existing glide. Pool 9 will be enhanced by installing a boulder cross vane to improve scour, and two habitat trees anchored to the structure and extending into the pool to provide cover and velocity shelter.

New small boulder clusters will be installed, and existing boulders in the channel in Riffle 9 and 10 will be adjusted to produce more effective pocket water and velocity shelter. 155 feet of stream bank will be stabilized using large wood and/or boulders embedded in the toe of the bank slope to create riparian benches at the bank-full elevation of the stream channel. Willows and sedge mats will be planted along these benches, creating a small riparian floodplain. 85 ft of stream bank will be re-vegetated without toe-slope stabilization. Stabilized slopes will be covered with biodegradable geo-textile fabric and planted with native willow, sedge and upland grasses.



Plan view of Habitat enhancements and bank stabilization from Pool 9 through the end of Reach 2 of Fountain Creek within The Fields Park.

Scour and pool depth will be improved in Pool 10 and Pool 11 through the installation of boulder cross vanes immediately upstream of these habitats. The existing log drop structure at Pool 12 will be removed, and replaced with a series of boulder cross vanes that will create a short pocket water cascade habitat to allow for fish passage and control any potential for a head-cut developing upstream of this feature. Care will need to be taken to assure that sediment in storage upstream of the existing log drop structure is not released downstream. A log/boulder J-Hook structure will be installed along the left bank of Pool 13 at the upstream boundary of the reach.

New small boulder clusters will be installed in Glide 9 and Riffle 15 to produce more effective pocket water and velocity shelter. 60 feet of stream bank will be stabilized using large wood and/or boulders embedded in the toe of the bank slope to create riparian benches at the bank-full elevation of the stream channel. Willows and sedge mats will be planted along these benches, creating a small riparian floodplain. 125 ft of stream bank will be re-vegetated without toe-slope stabilization. Stabilized slopes will be covered with biodegradable geo-textile fabric and planted with native willow, sedge and upland grasses.

Project Implementation Schedule:
Preliminary estimates are that this work would take approximately three to four weeks to complete, and would require the use of a 20-35K lb excavator with a hydraulic thumb and a front end loader. We estimate that 530 - 550 boulders (265 $yd^{3)}$ will likely need to be imported into the site in order to complete the work. Additionally, approximately 25 cottonwood or other trees, averaging 10"-16" DBH, will need to be secured to complete the toe-slope stabilization and riparian benching work. There is no available willow on site, so a source of willow needs to be determined for the project. A preliminary budget

estimate for completing habitat enhancements in Reach 2 is included in the appendix. This estimate should not be construed as a fixed cost proposal to complete the project by FIN-UP Habitat Consultants, Inc., and is provided solely for planning and fund-raising purposes for the City and the Fountain Creek Restoration Committee (FCRC).

Goals and Objectives of Habitat Restoration in Reach 2

- Greater sediment transport efficiency, as measured by increased maximum pool depth, residual pool depth and total volume within newly constructed pools within the reach.

- 996 feet of eroding stream banks stabilized and revegetated (42% of the total stream banks in the reach).

- 1/2 Acre of improved in-stream and stream bank riparian habitat along 1170 feet of Fountain Creek, including 20 Cross-Vanes to create or enhance pool habitats, 1 J-Hook Rock Vane to provide additional pool habitat, and 33 rock clusters to provide pocket water holding and feeding areas and velocity shelter within the riffle habitats of the reach.

- Improved educational and recreational opportunities within the park.

- Create multiple fish viewing areas within the park. Install interpretive sign describing aquatic/riparian ecosystems.

Glossary of Terms:

Benthic Zone - The benthic zone is the lowest level of a body of water. It is inhabited mostly by organisms that tolerate cool temperatures and low oxygen levels, called benthos or benthic organisms.

Cascade - A meso-habitat type. Cascades are the steepest riffle habitat types, in terms of gradient, in streams. These riffles consist of alternating small waterfalls and shallow pools. These habitats may appear to have the characteristics of a Step-pool system. Cascades are characterized by swift current flows and often have exposed rocks and boulders above the water surface, which creates considerable turbulence and surface agitation. The substrate normally found in cascades is bedrock or accumulations of boulders.

Cover - Locations where fish prefer to rest, hide and feed are called cover. Cover serves to visually isolate fish, which increases the number of territories in the same space. Additionally, cover can create areas of reduced velocities providing critical resting and feeding stations for fish. The amount of cover available in a stream can influence the production of a number of fish and invertebrate species.

Cross-Vane - A structure spanning the entire width of the channel, constructed of large boulders and/or large wood, that provides vertical stability, increased scour, increased stage upstream, and reduced stream power. This structure type is commonly used as a diversion structure for irrigation ditches, as well as for treating active down cutting and head cuts in the stream channel.

Embeddedness - The degree to which the interstitial spaces between larger substrate particles are filled with finer sediments. Embeddedness tends to armor the substrate, thus limiting available habitat for benthic dwelling macroinvertebrates and spawning habitat for salmonids.

Glide - A meso-habitat type. Glides are those portions of streams which have relatively wide uniform bottoms, low to moderate velocity flows, lack pronounced turbulence, and have substrates usually consisting of either cobble, gravel or sand. Glides are usually described as stream habitat with characteristics intermediate between those of pools and riffles. These habitats are commonly found in the transition between a pool and the head of a riffle, however they are occasionally found in low gradient stream reaches with stable banks and no major flow obstructions.

Green Line - A narrow band of riparian plant species immediately adjacent to the stream bank in deeply entrenched streams. These are typically streams that have no identifiable flood plains.

Head-Cut - An area of active down-cutting in the channel where a river or stream is eroding down to a new, lower flood plain.

Intermittent - An intermittent stream is one that only flows for part of the year.

Lotic - Of, relating to, or living in moving water such as streams and rivers.

Meso-Habitat - A channel scale habitat form. Typically a pool, riffle, rapid, cascade or glide habitat. A meso-habitat occupies the entire width of the stream channel, and with few exceptions (most notably plunge pools in high gradient step-pool systems) is at least as long as the channel is wide.

Micro-Habitat - Micro habitats are small, site specific habitats within a meso-habitat form, and may include spawning redds, in-stream or overhead cover, and velocity shelters.

Micro-Vortex - A small rock cluster structure that replicates pocket water habitat in riffles, rapids and cascades.

Over-Wintering Habitat - Areas of a stream or water body exhibiting depths that may sustain a population through the winter months.

Perennial - A perennial stream is one that flows year round.

Pocket Water - A micro-habitat type. Pocket water habitats are typically found in higher gradient riffles, rapids, and cascades with large cobble, boulder, and large woody debris. These pocket water habitats provide small areas for velocity shelter and cover within these fast-water habitat forms.

Pool - A meso-habitat type. Pools are channel segments exhibiting areas of scour and deposition where the water is deeper and slower moving.

Primary Producers - Primary producers are those organisms in an ecosystem that produce biomass from inorganic compounds. In almost all cases these are photosynthetically active organisms.

Rapid - A meso-habitat type. Rapids are riffles associated with high gradients (greater than 4%) with swiftly flowing (greater than 1.5 ft/sec), moderately deep, and highly turbulent waters. These riffles are generally associated with boulder substrates, which protrude through the surface of the water.

Residual Pool Depth (RPD) - Residual pool depth is estimated as the depth of water which would be retained in a pool under highly reduced flows or the stoppage of flows in the stream. This area of pools would be utilized by fish in low flow conditions. Residual pools would also provide habitat for overwintering of fish when ice buildup restricts movement in riffles or glides between pools. Residual pool depth is calculated by locating and measuring the greatest depth of the pool at the riffle crest (deepest point of the downstream boundary cross-section of the pool), and subtracting this value from the greatest measured depth of the pool habitat. The difference in these measurements is described as the RPD. RPD may be difficult to determine in some habitats, particularly dam pools with woody debris structural associations. In many of these habitat units, the RPD may actually be a very low value or zero due to water flowing through these debris dams.

Riffle - A meso-habitat type. Riffles are those areas of the stream in which turbulence in the water column is the major identifying characteristic, as a result of relatively high gradients. These units contain moderately deep to shallow, swift flowing water, and are characterized by boulder or cobble substrates. Riffles are very important for macroinvertebrate production, due to the availability of light and oxygen, and the corresponding vegetative growth on the bottom substrate. The quality of riffles, including low sediment deposition and resulting embeddedness can have a direct impact on fish populations. The cleaner and healthier the vegetative growth and benthic macroinvertebrate community, the more food there is for the fish population.

Salmonids - Salmonidae is a family of ray-finned fish, the only family of order Salmoniformes. It includes the well-known salmons and trouts; the Atlantic salmons and trouts of genus Salmo give the family and order their names.

Subfamily - Salmoninae
Brachymystax - lenoks
Oncorhynchus - Pacific salmon and trout
Salmo - Atlantic salmon and trout
Salvelinus - Char and trout (Brook trout, Lake trout)

Substrate - Stream substrate (sediment) is the material that rests at the bottom of a stream.

Thermal Refugia - Micro habitats found in streams and lakes that provide thermal protection for cold water species such as trout. These may include shaded areas, cool water springs, and deep water habitats.

Toe-Slope - The foot, or bottom, of the sloping bank of a stream. This is the area of the highest sheer stress and erosion potential on a stream bank, and is typically the point of failure leading to mass wasting and collapse.

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